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LP/SV Bladder Buoyancy Test Comparison

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Abstract

Background: The buoyancy of CF jet aircrew LP/SV is unknown and may not provide the minimum 35 lbs that is required. The buoyant force of the British MK 30 LCX is also unknown; however, this flotation device utilizes a large bladder and may replace the LP/SV. Aim: The aim of this experiment was to calculate and compare the buoyant force of the CF LP/SV and the British MK 30 LCX. Methods: Bladders were inflated using either a 35g or a 45g CO_2 canister. A Chatillon spring scale was used to measure the buoyant force following submersion. Results: The LP/SV and MK 30 LCX attained buoyant forces of 41 and 42 lbs respectively following inflation using a 35g CO_2 canister, and 45 and 53 lbs respectively following inflation using a 45g CO_2 canister. Conclusion: In all trials, both flotation devices produced buoyant forces greater that 35 lbs. The British MK 30 LCX produced larger buoyancy forces.

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Table of contents

List of figures

List of tables

1 LP/SV BLADDER BUOYANCY TEST COMPARSION

1.1 BACKGROUND

1. Past experiments with the Jet Aircrew LP/SV bladder yielded a consensus that the LP/SV's were not providing sufficient buoyancy for aircrew when submersed in water. Also, nowhere in the current LP/SV regulations does it state the actual buoyant force that the LP/SV can provide given a particular sized CO_2 canister.

2. The British use a very similar aircrew flotation device called the MK 30 LCX. It differs from the currently used LP/SV because it utilizes a larger bladder with greater overall surface area and volume. This British MK 30 LCX has the potential to replace the CF's current LP/SV.

3. The minimum required buoyant force is 35lbs

1.2 AIM

4. The aim of this experiment is to calculate and compare the buoyancy of the CF's LP/SV with the British's MK 30 LCX using two different CO_2 canisters, one of 35g, and the other of 45g.

1.3 METHOD

5. The experiment took place in the rear of Building 54 located at DRDC Toronto, Ontario on 10 May 2011 (see Annex A for pictures during testing). There were four personnel administering the experiment. The two bladders that were being tested were the CF's Jet Aircrew LP/SV bladder and the British MK 30 LCX bladder. Both bladders underwent two main tests. The first test fitted a 35g CO_2 canister and the second test fitted at 45g CO_2 canister to the bladders. The equipment used during the experiment is as follows:

a) 1 CF Jet Aircrew LP/SV Bladder, NSN: 4220-20-000-5621

b) 1 RFD Beaufort MK 30 LCX Bladder, NSN: 4220-99-549-6844

c) 2 35g CO_2 cartridge, NSN: 4220-21-903-1991

d) 2 45g CO_2 cartridge, NSN: 4220-41-000-4259

e) 1 3.5' x 2.0' x 2.0' plastic container

f) 1 Chatillon Type 100 Spring Scale

g) 1 45lb weight

h) 2 10lb weight

i) 1 Dorie H50 Digital Thermometer

j) 1 Water Hose

k) 1 Roll Nylon Paracord

l) 1 10’ rope

6. The experiment was conducted using the following procedure:

a. Experiment Preparation: The plastic container was filled with cold fresh water to a level approximately one inch below the top of the container. This is to ensure that neither the weights nor the LP/SV bladder come in contact with the bottom of the plastic container resulting in inaccurate data. Next, the spring scale was fitted to a location directly above plastic container and was held in place by the 10’ rope which was used to raise or lower the spring scale in order to fully submerse the LP/SV bladder.

b. Ballast and Dry Weight Determination: Both the CF and the British bladders were weighed to determine their dry weights. Then, the 45lb and 10lb weights were submersed in the water and weighed to determine their resulting buoyant force.

c. CF LP/SV Bladder Buoyancy Test: The CF LP/SV Jet Aircrew Bladder was attached to one 45lb weight using paracord. Then it was attached/hung to the end of the spring scale. The 35g CO_2 canister was then opened and the bladder inflated. Using the 10ft rope, the weights and inflated bladder were lowered into the water. If the bladder remained afloat, the bladder and weights were raised out of the water and fitted with a 10lb weight and lowered again. This process continued until the bladder became fully submerged. Once the scale stopped fluctuating, the value was recorded. The bladder was then deflated and fitted with a 45g CO_2 canister and the test was repeated.

d. British MK 30 LCX Bladder Buoyancy Test: The CF LP/SV Bladder was removed from the spring scale and the British MK 30 LCX Bladder was fixed to the spring scale and followed the same process as 6.c above.

e. Clean Up: The weights, bladder and spring scale were removed from the plastic container and left to dry. The plastic container was then drained and returned to its original location.

1.4 RESULTS

7. The observations/controls are represented in the following table:

Table 1: Experimental Observations

Water Temperature	7.8°C (280.3°K)
CF Jet Aircrew LP/SV Bladder Dry Weight	2.0 lbs
British MK 30 LCX Bladder Dry Weight	2.0 lbs
45lb Plate Submersed Weight	38 lbs
10lb Plate Submersed Weight	9.0 lbs

8. Using the above table, the actual buoyant force of the two bladders was calculated and is illustrated in the following table:

Table 2: Bladder Buoyant Force

Bladder Type	**35g CO2 canister**	**45g CO2 canister**
CF Jet Aircrew LP/SV Bladder	41 lbs	45 lbs
British MK 30 LCX Bladder	42 lbs	53 lbs

9. Sample calculations with regards to Table 2 are located in Annex B.

1.5 DISCUSSION

10. Firstly, the method used to administer this test was fairly basic, requiring simple tools such as the spring scale and various ballast weights. The fact that this test used such basic equipment results in potential inaccuracies in the results. Some areas where these inaccuracies could have occurred were during the lowering of the bladder/weights into the water. The manual lowering of the bladder caused the spring scale to oscillate and resulted in a slight difficulty in reading off the value. Another potential inaccuracy is due to the fact that the spring scale has minimum intervals of one pound. This limits the accuracy of the experiment. Finally, another potential cause for

inaccuracy is the fact that the scale value is read off simply by ones vision as opposed to a digital readout.

11. Secondly, the test was administered using fresh water at a temperature of approximately 8°C. Assuming a worst case scenario, an LP/SV will be used during the winter months, so a water temperature of 0°C would have produced more valuable results. Also, the probability that an LP/SV will be used in fresh water as opposed to salt water is low, so this test would also produce more valuable results if salt water was used. The main reason behind this is the fact that the density of fresh water at 0°C is 999.9kg/m^3 and the density of salt water at 0°C is 1025kg/m^3. The higher density of salt water results in an object of constant volume to produce a slightly larger buoyant force. Therefore the actual buoyant force of each bladder will be slightly higher in salt water assuming the same CO_2 canister is being used.

1.6 CONCLUSION

12. In conclusion, since this experiment was done to produce a fairly accurate estimate on the buoyancy of the CF Jet Aircrew LP/SV bladder versus the British MK 30 LCX bladder, the need for a digital scale readout or higher accuracy scale is unnecessary. Also, since the density of fresh water has almost zero change when comparing 8°C and 0°C, the results obtained are reasonably accurate. Lastly, since this test should be administered under a worst-case scenario, and noting that fresh water produces slightly less buoyant force than salt water, it is acceptable that this tests was done using fresh water. In the end, both models produced a buoyant force greater than 35lbs, however the British MK 30 LCX bladder produced larger buoyant forces using both the 35g CO_2 canister and the 45g CO_2 canister.

Annex A Pictures During Buoyancy Test

Figure 1 Determining Submersed Weight of 45lb Plate

Figure 2 CF Jet Aircrew LP/SV Bladder Attached to One 45lb and One 10 lb Plate That Are Acting to Counter The Buoyant Force. (35g CO_2 canister test)

Figure 3 Chatillon Type 100 Spring Scale Measurement Intervals

Figure 4 British MK 30 LCX Bladder Buoyancy Test using 35g CO_2 canister. Note that the hand in the photo was not producing any force in the vertical direction, it was simply ensuring that the connecting rope remained hooked on the spring scale.

Figure 5 CF Jet Aircrew LP/SV Bladder using a 45g CO_2 canister.

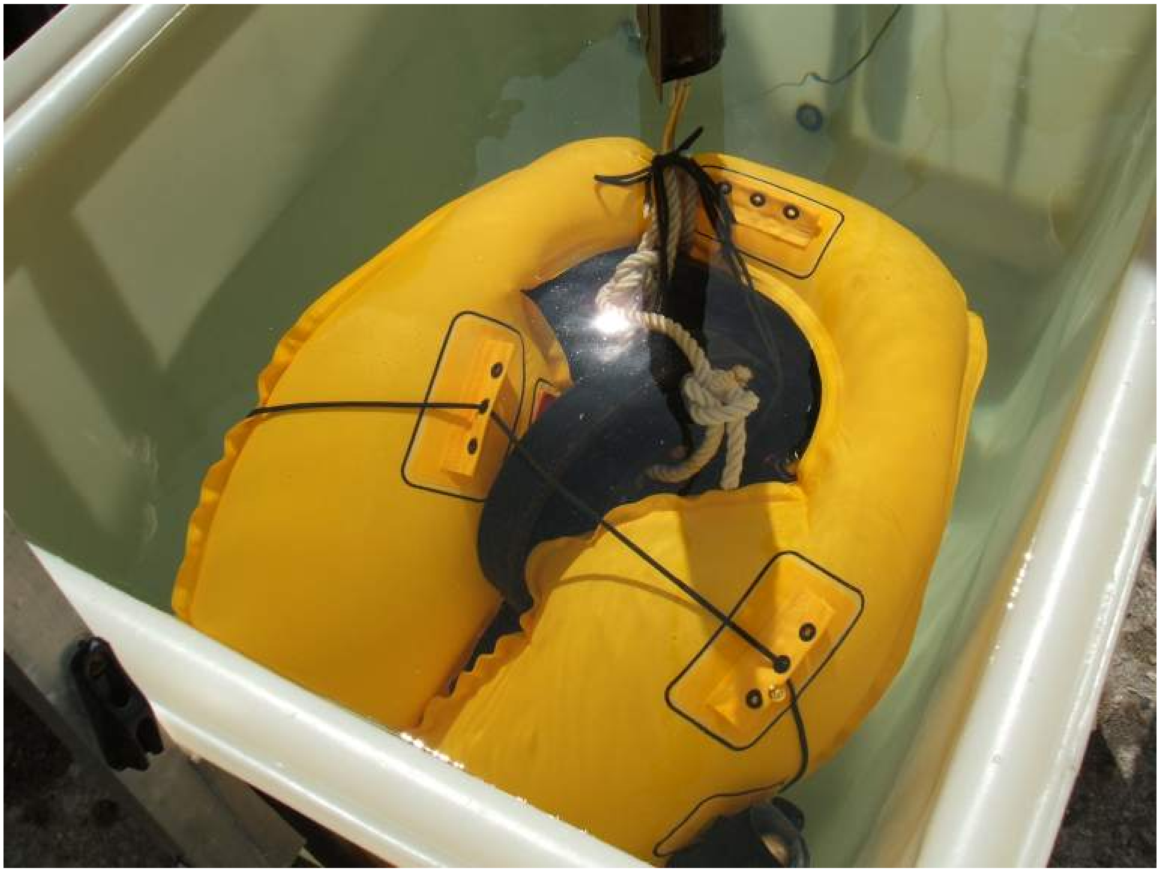

Figure 6 Buoyancy Test of CF Jet Aircrew LP/SV Bladder using 45g CO_2 canister

Annex B Sample Calculations

Test 1:

1. Total Weight:

= Bladder Dry Weight + 45 lbs Submersed Weight + 10 lbs Submersed Weight

= **2 lbs + 38 lbs + 9 lbs**

= **49 lbs**

2. After Bladder was lowered into water, the scale showed:

= **8 lbs**

3. Therefore, total buoyant force generated by inflated bladder:

= **49 lbs – 8 lbs**

= 41 lbs

Therefore it produced 41 lbs of buoyancy.

References

1. Firth, J.A, R.W. Smith and J.C. Steffler (1983), “Evaluation of Canadian Forces Life Preservers to Determine Compliance with Air Standardization Coordinating Committee Air Standard 61/4”, DCIEM No. 83-C-38, July 1983.

2. Martin, N.A. (1986), “Performance of Several Aircrew Life Preservers in Conjunction with Various Clothing Ensembles, DCIEM No. 86-R-24, May 1986

List of symbols/abbreviations/acronyms/initialisms

CF	Canadian Forces
CO_2	Carbon dioxide
DCIEM	Defence and Civil Institute of Environmental Medicine
DRDC	Defence Research Development Canada
LP/SV	Life Preserver/Survival Vest

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